CALFED Water Use Efficiency Program Proposal

A. Cover Sheet *(Attach to front of proposal.)*

1. Specify: ☒ agricultural project or ☐ urban project ☐ individual application or ☒ joint application

2. Proposal title—concise but descriptive: **Quantification of Benefits Attribuable to Irrigation Scheduling as An On-Farm Water Management Tool to Partially Address CALFED Quantifiable Objectives No. 106,107,164,167,168,176,193,196 and 197**

3. Principal applicant—organization or affiliation: **WaterTech Partners and JMLord, Inc.**

4. Contact—name, title: **Ronald J. Enzweiler, Principal/Owner, WaterTech Partners**

5. Mailing address: **WaterTech Partners, 5 Corte Fresca, Moraga, CA 94556**

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8. E-mail: **ron@h2o-tech.com**

9. Funds requested—dollar amount: $ **600,000**

10. Applicant cost share funds pledged—dollar amount: $ **765,000**

11. Duration—(month/year to month/year): **July 2001** to **June 2004**

12. State Assembly and Senate districts and Congressional district(s) where the project is to be conducted: **State Assembly #30 (Dean Florez*), #31 (Sarah Reyes) and #34 (Phil Wyman); State Senate #16 (Jim Costa*) and #17 (Wm. J. Knight); U.S Congress #20 (Calvin Dooley*) and #21 (William M. Thomas)** *main districts and elected officials

13. Location and geographic boundaries of the project: **19 farms covering 28,215 acres in Sub-Regions 10,14,15,16, 20 and 21 within Fresno, Kings and Kern Counties; the "reduce nonproductive ET" and "reduce flows to salt sink" QOs in these sub-regions will be addressed, along with the TBs for "reduce pesticides" and "reduce salinity."**

14. Name and signature of official representing applicant. By signing below, the applicant declares the following:
   - the truthfulness of all representations in the proposal;
   - the individual signing the form is authorized to submit the application on behalf of the applicant;
   - the applicant will comply with contract terms and conditions identified in Section 11 of this PSP.

Ronald J. Enzweiler *(printed name of applicant)*

February 15, 2001 *(date)*

(signature of applicant)

Quantification of Benefits Attributable to Irrigation Scheduling as an On-Farm Water Management Tool

to partially address CALFED Quantifiable Objectives
No. 106, 107, 164, 167, 168, 176, 193, 196 and 197

B. SCOPE OF WORK

1. Executive Summary

The goal of this project is to determine and document the **direct** and **indirect** on-farm cost savings and **externa**l benefits that growers can achieve by using irrigation scheduling to reduce applied water use and to maximize water-use efficiency on various crops in six hydrologic sub-regions of the San Joaquin Valley. Participants in this project will be 19 growers which farm 28,215 acres. The nine water districts serving these farms have been asked to be "cooperating agencies." The participating growers will contract with JMLord for commercial irrigation scheduling services over the three-year data collection and monitoring period (the 2002, 2003 and 2004 irrigation seasons). These local expenditures, which will total about $765,000, will be the local cost-share component of this project.

However, in addition to calculating crop water needs and monitoring irrigations per JMLord's typical irrigation scheduling services, JMLord will develop an annual water balance for each farm; calculate water use efficiency for each crop; monitor the use and costs of pesticides and fertilizers; document product quality improvements; and monitor runoff and groundwater salinity levels. This site-specific information will be recorded in a GIS data base for each field in each participating farm. In addition, crop yield, water use, and pesticide and fertilizer use data will be collected and reported at the ***district level*** for other growers in the cooperating districts. These district-wide data will be used to establish "benchmarks" against which data from the participating growers will be compared. Furthermore, the effects that reductions in applied water-use achieved by the 19 participating growers have on the CALFED **Quantified Objectives (QOs)** and **Targeted Benefits (TBs)** in the selected sub-regions will be ascertained and reported. A total of **$600,000** in CALFED Water Use Efficiency Program funding (for a 56% to 44% local-to-state cost sharing) is being requested under this RFP over the three project years. These CALFED funds will be used to cover the additional work to develop the GIS data base; quantify the QOs and TBs; conduct public outreach; and for project management.

This project will be performed by a multi-disciplined, experienced team led by **Ronald J. Enzweiler** *(Project Manager*), the principal/owner of WaterTech Partners, and **Joseph M. Lord** *(Technical Director),* the president/owner of JMLord, Inc. Mr. Enzweiler has served as project manager for similar R&D projects for the California Energy Commission, EPRI, and the National Renewable Energy Laboratory. He has 10 years consulting experience on water, wastewater and environmental issues. Mr. Lord has 30 years consulting and project management experience in agricultural and irrigation related work in the Central Valley. Over this period, Mr. Lord has built JMLord, Inc. into one of the largest and most respected private irrigation services firm in California. **Dr. Wesley Wallender**, a UC Davis professor and GIS data base expert, will serve as a consultant on the project.

2. Statement of Critical Water Issues Project Will Address, Need for Project and Consistency with Local and Regional Water Management Plans

Critical Water Issues

The **direct** benefits of ***irrigation scheduling*** (i.e., the use of scientific methods, weather data, and/or trained irrigation specialists to determine and apply the appropriate amount of irrigation water as needed to meet plant ET requirements) to ***individual growers*** are generally known for various crops and irrigation methods.[1] The **direct** benefits of irrigation scheduling, which can be fairly easily calculated, include: lower water and energy costs and increased yields. **Indirect** benefits, like improvements in product quality, reduced drainage, and less use of chemicals and fertilizers, are generally recognized, but are more difficult to ascertain and quantify for particular crops and irrigation methods; hence the value of indirect benefits are usually not considered when growers make the decision whether to use irrigation scheduling as part of their standard farming practices.

Because only cost savings resulting from **direct** benefits are typically considered, irrigation scheduling – whether performed by on-staff personnel or by outside service providers -- is presently practiced on less than **7.5%** of the irrigated farmland in the San Joaquin Valley.[2] Specifically, most growers are skeptical that the typical **$8-to-$25** per-acre per-irrigation season cost for irrigation scheduling will be cost effective. The proponents of this project believe that, if both the **direct** and **indirect** benefits to the grower of irrigation scheduling were determined and quantified for a variety of crops and irrigation methods across several sub-regions in the San Joaquin Valley, the **perceived lack of cost effectiveness** of irrigation scheduling would be disproved, and a much larger percentage of growers in the San Joaquin Valley would chose to use scientific irrigation scheduling as part of their standard farming practices.

[1] For example, two case studies documenting the **direct** benefits associated with irrigation scheduling are referenced in the introduction (pp. 3-4) to the 1999 UCCE publication, *Scheduling Irrigations: When and How Much Water to Apply* (B. Hanson, L. Schwankl, and A. Fulton). These two studies are: a 1991 report on a 6-year study (1983-86) on irrigating a walnut grove in Kings County ("Implementing CIMIS at the Farm Level: A Grower's Experience in Walnuts" by A. Fulton, R. Beede, and C. Phene); and a 1984 one-year study on cotton using the pressure bomb method ("Irrigation Scheduling Under High Water Tables" by S. Kite and B. Hanson). The proposed project will cover more cost variables and have broader application than these two prior studies, which did not consider and quantify the **indirect** and **external** benefits resulting from irrigation scheduling.

[2] In a 1997 study performed by the USDA ARS at Fort Collins, CO ("Implementing On-Farm Irrigation Scheduling" by G. W. Buchleiter and R. J. Wenstrom), the authors determined that, of the approximately 190,000 irrigated farms in the 27 leading irrigation states (including California), about 5% use commercial scheduling services, and another 2.5 % use in-house computer scheduling models to determine when and how much to irrigate. Based on their experience and knowledge, JMLord and Prof. Blaine Hanson at UC Davis (p.c., 2/2/01) estimate this 7.5% figure probably holds true today in the San Joaquin Valley. Indeed, a recent survey of CIMIS users ("Publicly Funded Water Database Benefits Users Statewide," by D. Zilberman, et. al, *California Agriculture*, May-June 2000) indicates usage of CIMIS by 5.8% of the growers in the 7-county San Joaquin Valley area (285,000 acres using CIMIS out of 4.8 million total acres in agricultural use.) Assuming another 1% to 2% use private weather station data or the pressure-bomb method, this survey confirms the 7.5% estimate.

Moreover, as individual business owners, growers are only willing to pay for benefits that accrue to ***them*** based on ***their*** actual costs. Thus, no consideration is given to **external** (i.e., off-farm) benefits resulting from irrigation scheduling. Potential **external** benefits include reduced downstream water quality degradation (e.g., less entrained chemicals and sediments), reduced diversions during critical periods, and reduced applied water use that makes additional supplies available to other beneficial water users. While of lesser interest to individual growers, these **external** benefits achieve many CALFED program objectives.

Need for Project

Although irrigation scheduling has been researched, advocated and practiced in various forms in California for over 30 years, the proponents of this project are not aware of any published, broad-based, multi-year case studies and "testimonials" that serve to validate the **direct** and **indirect** economic benefits that growers in **California** can expect to achieve by practicing scientific irrigation scheduling.[3] Significantly more research on the benefits of irrigation scheduling – including the indirect benefits -- has been performed in other states.[4] For example, the direct and indirect benefits of irrigation scheduling are documented in USDA-sponsored study performed on a 4,200 acre farm in south central **Kansas** over a 10-year period ending in 1996. In this study, a computerized irrigation scheduling program using weather data was used to calculate crop water requirements. As a result, groundwater pumping costs were reduced by 20% and fertilizer savings were achieved. This study validated total savings to the grower of $77/acre, against costs of $20/acre, for a net profit increase of $57/acre.[5] The proposed project will document and quantify in a similar manner the total cost savings and **net profit increase** that California growers are able to achieve using scientific irrigation scheduling over a multi-year period.

Consistency with Local and Regional Water Management Plans

The primary purpose of this project is to promote water-use efficiency among agricultural water users by expanding the use of weather-data based irrigation scheduling in the San Joaquin Valley. Specifically, this project will extend the application, and thus increase the local and regional benefits, of the Department of Water Resources' CIMIS program.

[3] A review of the literature (i.e., USDA's TEKTRAN and ARICOLA data bases; UC Cooperative Extension Service, ITRC and CIT publications; and periodicals like *California Agriculture*) revealed only the two previously cited case studies on the **direct** benefits of irrigation scheduling. The previously cited survey of CIMIS users (Zilberman,, et. al) includes a county-by-county "benefit per acre" figure for using CIMIS as derived by UC Berkeley economists from *grower reported* yield and water use changes attributable to the use of CIMIS. The "benefit per acre" figures in this survey range from **$48 to $324** per-acre per-irrigation season for San Joaquin Valley growers. This study also reports *calculated* applied water-use savings of **3.4 inches per acre** (about 80,000 acre-feet per year on 285,000 irrigated acres) for CIMIS users in the San Joaquin Valley. These "survey" and "calculated" figures on the benefits of CIMIS and other scientific irrigation scheduling need to be validated by field data to be credible to growers. This project will meet this need by providing benefit figures based on ***actual field measurements*** taken by professional agricultural engineers and scientists.

[4] None of the first 25 reports that came up in a search of the USDA's TEKTRAN data base under "irrigation scheduling" pertained to California. Texas(12), Kansas (4) and Arizona (3) had the most reports.

[5] *ob cit.*, Buchleiter and Wenstom

Furthermore, this project will support implementation of the Agricultural Water Management Council's *Memorandum of Understanding for Efficient Water Management Practices*, which has been adopted by CALFED and is included Attachment B in the *Proposal Solicitation Package*. The local water districts serving the participating farms in this project support water-use efficiency and endorse the MoU's principles. This project will directly support implementation of following excerpted provisions of the MoU:

List A – Generally Applicable Water Management Practices

3. *Support the availability of water management services to water users*. The purpose of this project is to create more awareness of the benefits of using weather-data based irrigation scheduling. Several private firms, including JMLord, offer irrigation scheduling services to growers in the San Joaquin Valley on a contract service basis. This project will highlight the benefits and availability of such services and is expected to increase the adoption rate among growers. The project team will make the software developed as part of the project, including the GIS data base programs used to record water use at the farm and water district level, available at no (or nominal) cost to any other water districts, public agencies or private consultant requesting such programs.

4. *Where appropriate provide improved communications and cooperation among water suppliers, water users, and other agencies.* As part of the scope of work, the project team will publish one or more technical articles on the results of this project and will make one or more presentations at agricultural forums, such as meetings sponsored by the California Irrigation Institute, the Association of California Water Agencies, and the American Society of Agricultural Engineers.

5. *Evaluate the need, if any, for changes in policies of the institutions to which the water supplier is subject.* This matter will be investigated with respect to the ability of individual growers – as beneficial water users -- to receive credit and monetary value from water suppliers (e.g., the Dept. of Water Resources and U.S. Bureau of Reclamation) and/or other public entities (e.g., the new CALFED governing entity) in consideration of the **external benefits** achieved by the use of irrigation scheduling services. Such credits would be one way to provide financial incentives to growers -- above their on-farm net cost savings -- to motivate a greater number of growers in particular sub-regions to practice irrigation scheduling. From the water supplier's perspective, it may be more cost effective to pay growers a certain amount on a **recurring annual basis** to partially subsidize their costs for practicing irrigation scheduling in order to ***reduce demand,*** and thereby avoid (or delay) the need for costly new water supply sources.[6] This project will develop the data needed to devise and justify such a program since the value of the **external** benefits (i.e., the **QOs** and **TBs**) attributable to irrigation scheduling will be determined for 19 farms in six San Joaquin Valley sub-regions. Moreover, the GIS data base that will be developed will provide a means for tracking and monitoring the implementation of such CALFED-run program.

[6] This would be analogous to the state's current program for subsidizing energy-use conservation measures (e.g., rebates for more efficient appliances) as a way to reduce demand as part of the solution to the state's electric power crisis. In this case, the subsidiary would be for a recurring service (not a one-time expense), and public funding should be considered since the ***replacement value*** of the saved water is over 8 times the grower's cost.

List B –Conditionally Applicable Water Management Practices

4. *Facilitate voluntary water transfers that do not unreasonably affect the water user, water supplier or the environment*. Although water transfers are not part of this project, this project will document ***baseline*** water use and the ***net water savings*** (i.e., reductions in applied water use less recoverable losses) achieved by the 19 participating farms over the three-year project period. Such data may be used by the participating growers and/or water districts *in the future* as part of the documentation necessary for obtaining regulatory approvals and concluding voluntary water transfers and/or water sales. As part of this project, the regulatory and other issues associated with undertaking water transfers based on the *net water savings* achieved by practicing irrigation scheduling will be investigated in the case of each participating farm. This investigation will also attempt to determine the potential economic gain that individual growers and/or water districts could expect to obtain from such water transfers or sales.

List C – Other Efficient Water Management Practices

Water Measurement and Water Use Report The GIS data base that will be developed as part of this project will include an annual *water use report* for each field in each of the 19 participating farms. In addition to crop and water-use data, these field-level reports will include fertilizer- and pesticide-use data. These field-level reports will be aggregated in a farm-level report.[7] The farm-level reports produced as part of this project will serve as "case examples" of the type of water, fertilizer and pesticide use data that would be available to other growers in the water district (or hydrologic sub-region) if, at some point in the future, *all farms* in the district (or sub-region) were included in the GIS data base.[8] Although the collection of actual field-level data and the development of a GIS data base for *all farms* in the participating water districts or sub-regions is beyond the scope of this project, the project team will attempt to obtain generalized information on water, fertilizer and pesticide use *by crop* for all other farms in the participating water districts and applicable sub-regions over the three-year project life. These district- and sub-region-level data *by crop* will be compared to the data *by crop* obtained from the participating farms. These "same conditions" comparisons will show the true cost benefits attributable to irrigation scheduling.

3. Nature, Scope and Objectives of Project

The 19 farms (identified by their JMLord identification numbers) expected to participate in this project are listed in Table 1. As shown, these farms cover **28,215 acres** in **six** different hydrologic sub-regions. While the 19 candidate farms are less than 1% of all agricultural land in the San Joaquin Valley, they represent about **8%** of all farms currently using scientific irrigation scheduling (i.e., 28,215 acres out of 360,000 acres, assuming

[7] The identity of the individual farmers participating in this project and data about their farming operations will be kept confidential. No names will be disclosed or used in publicly released documents, unless a participant's approval is obtained. All contact with participating farmers will be made through JMLord.

[8] JMLord recently completed the development of a GIS data base that includes crop and water-use data by field for all farms in the Coachella Valley Water District. The project team is not aware of the existence of a similar GIS data base that tracks water use and costs on a field-by-field basis in the San Joaquin Valley.

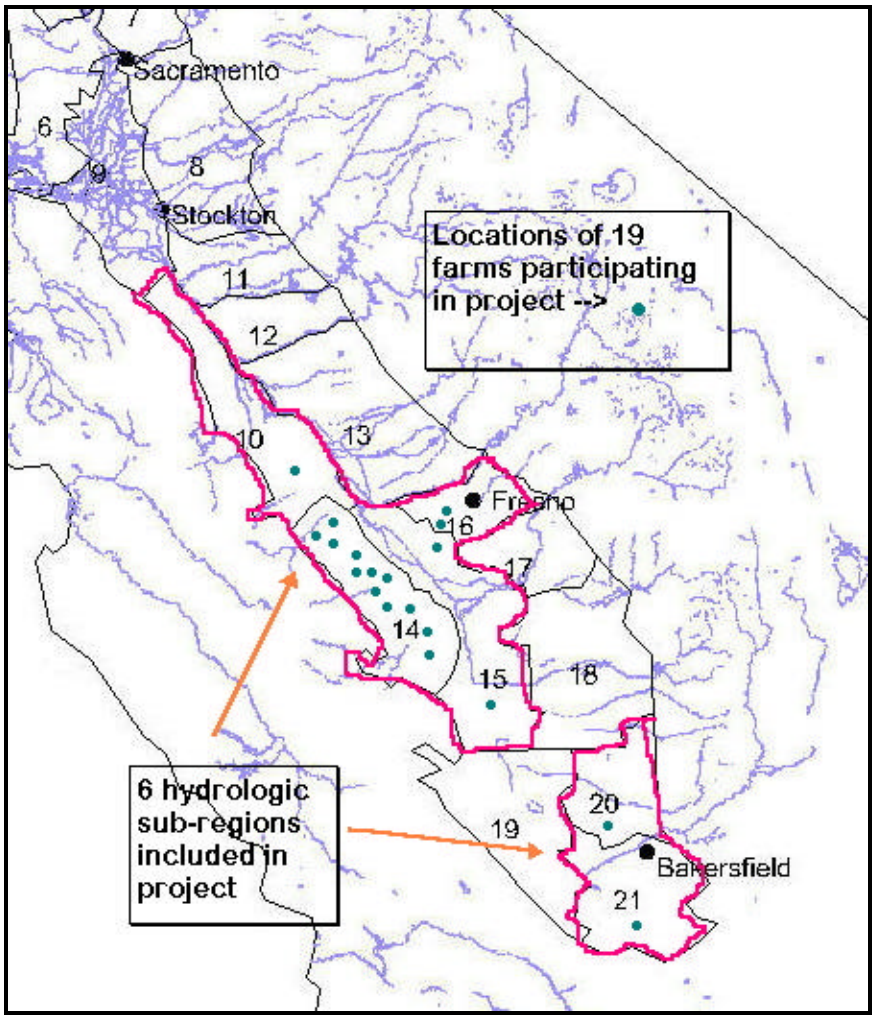
7.5% of all 4.8 million acres of farmland in the San Joaquin Valley uses scientific irrigation scheduling). The project proponents believe that this "sample size" is large and diverse enough so that the results can be extrapolated to the entire San Joaquin Valley.

Table 1
Proposed List of Farms Participating in Project[1]

Participating Farms (JML ID No.)	Irrigation Districts	Total Acres in Project	Crops	Cost Sharing Commitment[2]
Sub-Region 10 : Valley Floor West of San Joaquin River				
I00611	Columbia Canal Co.	383	tomatoes	$ 20,820
Sub-Region 14: Westlands Area				
I01551	Westlands W. D.	765	cotton, grains	$ 26,610
I01607	Westlands W. D.	762	cotton, tomatoes, trees	26,610
I01608	Westlands W. D.	820	cotton, tomatoes, trees	30,810
I01926	Westlands W. D.	641	cotton, onions, grains	22,116
I01928	Westlands W. D.	510	cotton, grains	12,510
I01929	Westlands W. D.	270	cotton, grains	5,310
I01930	Westlands W. D.	340	cotton, grains	7,860
I01931	Westlands W. D	465	cotton, grains	11,160
I01932	Westlands W. D.	780	cotton, onions, grains	11,700
I01012	Westlands W. D.	450	onions, tomatoes	14,175
I013053	Westlands W. D.	634	cotton	20,922
I00860	Westlands W. D.	2,444	tomatoes	99,504
Sub-Total:		8,881		$ 289,287
Sub-Region 15: Mid Valley Area				
I01691	Lemoore Canal Co.	8,647	cotton, grains, onions, tomatoes, beans, alfalfa	$ 112,890
I01919	Tulare Lake W.S.D.	6,105	cotton, tomatoes	164,835
Sub-Total:		14,752		$ 277,725
Sub-Region 16: Fresno Area				
I01450	Crescent Canal Co.	537	cotton, grains	20,286
I01645	Crescent Canal Co.	1,683	cotton	94,395
Sub-Total:		2,220		114,681
Sub-Region 20: Eastern Kern County				
I00493	North Kern W.S.D. & Cawelo W.D.	1,336	vines	40,803
Sub-Region 21: Kern River Area				
I00493	Arvin-Edison W.S.D & Wheeler Ridge-Maricopa W.S.D.	643	trees	21,789
TOTAL PROJECT:		28,215		$ 765,000

[1] tentative list of participating growers; this list will be finalized after the proposal is selected for funding
[2] projected over 3-year project life at 3 times each farm's expected expenditure for 2001 irrigation season

Map Showing CALFED Hydrologic Sub-Regions and Approximate Locations of 19 Farms Participating in Project



The scope of work for this project will include the following tasks:

- **Task 1: Project Start-Up**

  After authorization to proceed is given and prior to the start of the irrigation season in the first project year (2002), JMLord will create a Graphic Information System (GIS) data base for all 28,215 acres of cropland included in the project. This program will be a multi-layered, multiyear data base capable of generating "bottoms ups" reports at the field, farm, water district and sub-region level. Data cells will be created and baseline "benchmark" values[9] entered for: water sources, uses and costs; fertilizer usage and costs; pesticide usage and costs; crop type, quality ratings, yields, and market values; and, as applicable, groundwater conditions (depth, salinity and trace chemicals) and site run-off (quantify, sediment

[9] Benchmark values will be derived from comparisons between 1) project fields and 2) non-project fields in the same district with similar crops and irrigation systems, but which do not practice scientific irrigation scheduling.

load and trace chemicals). These baseline data will be collected by field visits and observations; interviews with growers and water district personnel; and satellite imagery. The software programs and hardware items listed in the cost section of this proposal will be acquired during this start-up period. This work will be performed at JMLord's offices in Fresno, California. **Dr. Wesley Wallender**, a professor in Departments of Land, Air and Water Resources (Hydrology Program) and Biological and Agricultural Engineering at UC Davis will be engaged as a consultant. Dr. Wallender, who has GIS expertise in agricultural applications, will assist JMLord in the design, development and use of this data base.

- **Task 2: Project Technical Activities**

During the irrigation seasons in project years 1, 2 and 3, JMLord will perform "basic" irrigation scheduling services on the 19 farms and the 28,215 acres of cropland included in the project. These basic services include having a trained JMLord irrigation professional visit each farm on a weekly or bi-weekly basis during the irrigation season; taking soil and water samples from multiple locations in each field; performing in-field soil moisture analyses; performing analyses at JMLord's Fresno laboratory to determine nutrient availability in the soil; monitoring and recording CIMIS and other available weather data for each farm; computing a water balance and irrigation schedule for each field; providing the grower with a recommended irrigation plan and assisting the grower in performing irrigations; and recording and providing the grower with a computer generated report on the amount the irrigation water used over the course of the current irrigation season. In addition to these basic services, JMLord will collect data on other variables being studied (water costs, fertilizer and pesticide use, salinity, etc.) and will input these data into the GIS data base. Supplemental laboratory analyses will be performed as needed to obtain data on these additional variables. In parallel with this work, WaterTech will evaluate the impact that irrigation scheduling has on the **QOs** and **TBs** in the applicable sub-regions; compile data to make cost comparisons with growers not using irrigation scheduling; and evaluate water transfers and other CALFED program and policy issues.

- **Task 3: Reporting and Outreach**

A key element of the project will be to publicize the results that are achieved and to transfer the expertise that is developed regarding GIS data bases to other agricultural water users and irrigation districts. Specifically, in years 2 and 3 of the project, JMLord will provide "hands-on" training to irrigation district staff members and other persons who wish to learn how to set-up and use a GIS data base to track water use and other variables as part of a comprehensive irrigation management program. In addition, project team members will produce and publish one or more technical papers and make presentations at seminars sponsored by the CIT, the ITRC, the ASAE, and similar agricultural technical organizations. WaterTech will also provide project management services over the 42-month the project life, including tracking costs, preparing billing statements, submitting quarterly progress reports, and performing all other required administrative tasks.

Objectives and Benefits

The overarching objective of this project is to create greater awareness among the agricultural water users in the San Joaquin Valley that growers can ***maximize their profits*** by using scientific irrigation scheduling methods to determine when and how much irrigation water to apply to their crops. The key to getting more growers to adopt irrigation scheduling is to document and quantify the **direct** and **indirect** benefits they can achieve. This project will accomplish this task by creating a GIS data base to record and track cost variables on a field-by-field and year-to-year basis by growers practicing irrigation scheduling, and then make "same conditions" comparative analyses with growers not practicing irrigation scheduling.

If more growers in the San Joaquin Valley practiced scientific irrigation scheduling, significant **external** benefits would accrue to society based on the reduction in water use that would result. Preliminary studies have shown that, by using scientific irrigation scheduling practices, growers can reduce applied water-use by **9%** -- but currently only **7.5%** of all growers use irrigation scheduling.[10] If this adoption rate were increased by a factor of four to **30%** (i.e., an increase from 360,000 acres to 1.4 million acres using irrigation scheduling), the reduction in applied water-use in the San Joaquin Valley would be **300,000 acre-feet/year**. [11]

The reduction in applied water-use and possible associated reductions in fertilizer and pesticide use that can be gained by increasing the adoption rate of scientific irrigation scheduling among San Joaquin Valley growers will contribute to numerous **QOs** and **TBs** identified for the agricultural component of the CALFED WUE program. The specific **QOs** and **TBs** that this project will **directly** address and contribute towards achieving based on the locations of the 19 participating farms are identified in Tables 2 and 3 below.

Table 2
Specific Quantified Objectives Directly Addressed by Project

Sub-Region	No.	Intended Outcome	QO (TAF/yr)
10	106	Decrease flows to salt sinks to increase water supply	49-111
	107	Decrease nonproductive ET to increase water supply	8.7
14	164	Decrease nonproductive ET to increase water supply	8.9
15	167	Decrease flows to salt sinks to increase water supply	<1
	168	Decrease nonproductive ET to increase water supply	6.1
16	176	Decrease flows to salt sinks to increase water supply	7.3
20	193	Decrease flows to salt sinks to increase water supply	8.1
21	196	Decrease flows to salt sinks to increase water supply	<1
	197	Decrease nonproductive ET to increase water supply	6.4
TOTAL POTENTIAL QUANTIFIED OBJECTIVES :			**95 - 157**

[10] *ob cit.*, Zilberman (Based on data in the CALFED *Details of Quantifiable Objectives* booklet that is part of the RFP, applied water use on the 4.8 million acres of irrigated cropland in the San Joaquin Valley averages about 40 inches per acres; hence, the 3.4 inches per acre savings reported by Zilberman represents a 9% reduction.)

[11] 1.08 million additional acres x 3.4 inches/acre/yr (= 0.28 acre-ft/acre/yr) is 300,000 acre-ft/yr. If **15%** of this figure represents reductions in ***nonproductive ET*** and ***flows to salt sinks***, the overall potential contribution this "action-specific" project would have for all such **QOs** in sub-regions 10 to 21 (which total 191,000 acre-ft/yr) would be **45,000 acre-ft/yr**. Thus, this project can achieve **23%** of the total target for these **QOs** in the SJV.

Table 3
Specific Targeted Benefits Directly Addressed by Project

Sub-Region	No.	Intended Outcome	Locations
10	101	Reduce pesticides to enhance and maintain beneficial uses of water	San Joaquin River
	104	Reduce salinity to enhance and maintain beneficial uses of water	San Joaquin River at Vernalis

Note: By encouraging the use of irrigation scheduling throughout the San Joaquin Valley, this project will also **indirectly** address the "reduce pesticides" **TBs** in sub-region 11 (#120 and #121), sub-region 12 (#137), and sub-region 13 (#152) for the San Joaquin and Stanislaus Rivers and the "reduce salinity" **TB** in sub-region 10 (#103) for Mud and Salt Sloughs.

1. Methods, Procedures and Facilities

The same methods, procedures, personnel, expertise, computer programs, offices and laboratory facilities that JMLord, Inc. has developed over the last 25 years and uses in it is commercial agricultural consulting practice in California and other western states will used on this project. In particular, JMLord has pioneered the development of and uses the "water balance" method of irrigation scheduling. The water-balance method of irrigation scheduling makes use of CIMIS or other weather station data, and is the most commonly used scientific method of irrigation scheduling in California and other western farm states. JMLord has the internal capabilities and will provide the staff, resources and facilities (including analytical laboratory services) necessary to perform all aspect of the irrigation scheduling work and other field work set forth in the scope of work statement.

JMLord has also pioneered the development and use of GIS data bases to record and track farming data on a field-by-field basis. However, in order to perform the GIS work required under this project, JMLord will need to procure approximately $60,000 in additional software programs and computer equipment. (This expense is included as part of Task 1 in the budget presented in Exhibit B). In addition, since the development and use of GIS data bases for agricultural applications is a relatively new field, Dr. Wesley Wallender, a UC Davis professor who specializes in this field, will be retained as a consultant. (The cost for the services of Dr. Wallender is included in the subcontractor column in Exhibit B.)

2. Schedule

A bar chart schedule and spending plan by quarter by funding source over the 3½ year project life is presented in Exhibit A. This schedule and spending plan was developed to meet two essential criteria: first, to obtain and record actual field data over ***three*** 9-month irrigation seasons (2002, 2003 and 2004); and secondly, to expend all funds provided by the CALFED grant within 3 years of the grant award date (assumed to be July 1, 2001).

3. Monitoring and Assessment

The GIS data base that will be developed as part of this project will provide the means for post-project monitoring and assessment Indeed, the development of a GIS data base is included in the scope of work specifically for this purpose. After the project is completed, copies of the GIS data base files created as part of the project will be given to the involved growers and water districts, along with all comparative data that has been developed.

C. Outreach, Community Involvement and Information Transfer

1. Outreach Efforts and Involvement of People from Disadvantaged Communities

Attempts have and will be made to contact and involve as many growers in this project as reasonably possible, including growers from disadvantaged backgrounds. During the technology transfer/community outreach phase of the project, presentations will be made in economically depressed areas of the San Joaquin Valley.

2. Training, Employment and Capacity Building Potential

As part of the scope of work for this project (Task 3.2), JMLord will provide "hands on" training to growers and other interested persons in the use of a GIS data base to record and track farming variables on a field-by-field and year-to-year basis. These workshops will be held at JMLord's offices in Fresno (or other convenient locations, such as the CIT in Fresno or the ITRC in San Louis Obispo) during the final year of the project.

3. Plan for Disseminating Information

As part of the scope of work for this project (Tasks 3.3 and 3.4), WaterTech and JMLord will prepare and publish one or more technical papers describing this project and reporting the results, and will make presentations at appropriate irrigation forums and seminars.

4. Letters Sent to Local Agencies and/or Other Impacted or Cooperating Agencies

Project team members will contact the water districts and growers who are expected to be participants as soon as this project is selected for funding. Letters, in the form presented in Exhibit C, will be used for this purpose. The list of participating districts and growers will be finalized prior to the signing of the project agreement with the CALFED agency.

D. Qualifications of the Applicants, Cooperators, and Establishment of Partnerships

1. Résumés of Project Team Personnel

The résumés of Ronald J. Enzweiler (Project Manager) and Joseph M. Lord (Project Technical Director) as well as other key personnel from WaterTech Partners and JMLord who will be participating in the project are included in Exhibit D.

2. External Cooperators/Consultant

Dr. Wesley Wallender, whose résumés is included in Exhibit D, is the only external consultant who will be used on this project.

3. Partnership Arrangement

WaterTech Partners (a sole proprietorship) will be the prime contractor and will be the entity which enters the project agreement with the CAFLED funding agency. JMLord will work as a subcontractor to WaterTech. Both parties will charge to the project in accordance their normal rate schedules and billing practices; however, neither firm will charge a fee-for-profit.

E. Costs and Benefits

1. Budget Summary and Breakdown

A project budget providing the information requested in the RFP is included as Exhibit B. As shown in this exhibit, the total project cost is **$1,365,000** with 56% of this amount ($765,000) as the local share and 44% ($600,000) being provided as a CALFED grant.

2. Budget Justification

As shown in Exhibit B, the cost for basic irrigation scheduling services for the 19 participating farms over the three-year project life is $762,000. The extra work to develop the GIS data base, quantify all direct, indirect and external benefits over three years, conduct the technology transfer and community outreach programs, and perform project management and administration tasks will cost an additional $600,000. The CALFED grant is being requested to cover these additional costs. All estimates for labor, equipment, supplies and travel are based on WaterTech's approved contracting rates (shown on Exhibit B), JMLord's standard commercial rates, vendor equipment quotes, and travel by car or truck at $0.33 per mile and state's allowed per diem rates.

3. Benefit Summary and Breakdown

Since the objective of this project is to determine and quantify the benefits attributable to using scientific irrigation scheduling under various conditions and locations, it is not possible to delineate the benefits in advance. The participating growers will pay about **$10** per-acre per-irrigation season for the basic irrigation scheduling services that will be provided as part of this project. Hence, their expected **direct** and **indirect** cost benefits exceed $10 per-acre, but are they really as high as **$48** to **$324** per-acre as claimed in the Zilberman CIMIS study? Moreover, previous studies indicate an approximate 9% reduction in applied water-use can be achieved on the 28,215 acres included in this project. This equates to a savings of 8,000 acre-feet per year – enough water to keep 2,500 acres of cropland in production in areas experiencing water supply deficits. What is the value of keeping farmland in production? If this project is able to increase the adoption rate of irrigation scheduling in the San Joaquin Valley from 7.5% to **30%** (a plausible goal), the saving in applied water use would be about 300,000 acre-feet per year[12] -- enough water to keep over 90,000 acres in production during periods of water supply deficits. And even in normal supply years, significant reductions in pesticide and nutrient runoff into the San Joaquin River system -- and eventually the Bay-Delta -- will be achieved. An objective of this project is to quantify these **external** benefits, including reductions in irrecoverable losses. In addition to making contributions to the **QOs** for ***reductions in nonproductive ET*** and ***flows to salt sinks*** in the San Joaquin Valley, the saved water may represent opportunities under CALFED's water transfer program.

4. Assessment of Costs and Benefits

The project proponents believe substantial benefits will accrue to CALFED from this project, but they can not be quantified in advance. A determination of CALFED benefits and policy recommendations are included in the scope of work (Tasks 2.7 and 2.8).

[12] CALFED studies have shown the cost to develop 300,000 acre-ft of new all-years supply (such as raising Shasta Dam by 100 feet) would be several billion dollars, and water from such a project would cost in the $1,000 per acre-foot range. This $600,000 WUE project could achieve the same benefits, but at much lower costs.

Exhibit A

Project Schedule & Spending Plan by Quarter

$1,000

	2001		2002				2003				2004				TOTAL PROJECT
	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	
Project Start-Up Tasks															
1.1 Kickoff & Organizational Tasks	13														$12,660
1.2 Set-up GIS Data Base	43	43													85,215
1.3 Sign Contracts w/Participants	6	6													11,060
1.4 Obtain Baseline Data		12													12,430
Project Start-Up Totals	**$61**	**$61**													$121,365
Project Technical Activities															
2.1 Irrigation Scheduling Services			85	85	85		85	85	85		85	85	85		$762,000
2.2 Obtain Field Data on Variables				27	27			27	27			27	27		164,125
2.3 Data Entry & GIS Work					15	15			15	15			15	15	90,000
2.4 Extra Analytical Lab Work			3	3	3		3	3	3		3	3	3		30,000
2.5 Determine & Evaluate Benefits				3	3	3		3	3	3		3	3	3	24,300
2.6. Develop Comparative Data					2	2			2	2			2	2	14,580
2.7 Assess CALFED Program Benefits										5	5				9,720
2.8 Develop Policy Recommendations											4	4			7,290
Project Activity Subtotals			**$88**	**$118**	**$135**	**$20**	**$88**	**$118**	**$135**	**$25**	**$97**	**$122**	**$135**	**$20**	$1,102,015
Reporting & Outreach Activities															
3.1 Project Management & Reporting	6	6	6	6	6	6	6	6	6	6	6	6			$76,900
3.2 Training on GIS Program									8	8	8	8			30,350
3.3 Prepare & Publish Final Report											5	5	5	5	20,080
3.4 Conferences & Seminars													7	7	14,290
Report Activity Subtotals	**$6**	**$6**	**$6**	**$6**	**$6**	**$6**	**$6**	**$6**	**$14**	**$14**	**$19**	**$19**	**$12**	**$12**	$141,620
Cost Share Funding			$73	$73	$73	$0	$73	$73	$73	$0	$73	$73	$148	$32	$765,000
CALFED Funding	67	67	21	51	69	27	21	51	76	39	42	68			$600,000
PROJECT TOTAL	**$67**	**$67**	**$94**	**$124**	**$142**	**$27**	**$94**	**$124**	**$149**	**$39**	**$116**	**$141**	**$148**	**$32**	**$1,365,000**

CALFED Spending by Contract Year: |-------- YEAR 1 --------> **$207** |-------- YEAR 2 --------> **$168** |-------- YEAR 3 --------> **$225**

2/15/01

Exhibit B

PROJECT BUDGET DETAIL BY TASK & COST ELEMENTS

	Personal Services		Operating Expenses					Other		TOTAL		
	Direct Labor*	Fringe Benefits*	Subcontract Services	Materials	Equipment	Travel	Misc.	Indirect Overhead	G&A Overhead*	Local Cost Share	CALFED Funds	Total Project
Project Start-Up Tasks		**15.0%**						**N/A**	**20.0%**			
1.1 Kickoff & Organizational Tasks	$3,600	$540	$7,500			$300			$720	-	$12,660	$12,660
1.2 Set-up GIS Data Base	900	135	25,000	$25,000	$25,000	-	$9,000		180	-	85,215	85,215
1.3 Sign Contracts w/Participants	3,600	540	5,000			$1,200			720	-	11,060	11,060
1.4 Obtain Baseline Data	1,800	270	10,000			-			360	-	12,430	12,430
Project Start-Up Totals	**$9,900**	**$1,485**	**$47,500**	**25,000**	**$25,000**	**$1,500**	**$9,000**	**$0**	**$1,980**	**$0**	**$121,365**	**$121,365**
Project Technical Activities												
2.1 Irrigation Scheduling Services	$0	$0	$750,000			$12,000			$0	$700,000	$62,000	$762,000
2.2 Obtain Field Data on Variables	7,500	1,125	150,000			4,000			1,500	-	164,125	164,125
2.3 Data Entry & GIS Work	-	-	90,000						-	-	90,000	90,000
2.4 Extra Analytical Lab Work	-	-	30,000						-	-	30,000	30,000
2.5 Determine & Evaluate Benefits	18,000	2,700	-						3,600	-	24,300	24,300
2.6. Develop Comparative Data	10,800	1,620	-						2,160	-	14,580	14,580
2.7 Assess CALFED Program Benefits	7,200	1,080	-						1,440	-	9,720	9,720
2.8 Develop Policy Recommendations	5,400	810	-						1,080	-	7,290	7,290
Project Activity Subtotals	**$48,900**	**$7,335**	**$1,020,000**	**$0**	**$0**	**$16,000**	**$0**	**$0**	**$9,780**	**$700,000**	**$402,015**	**$1,102,015**
Reporting/Out Reach Activities												
3.1 Project Management & Reporting	$ 54,000	$8,100				$4,000			$10,800	$10,000	$66,900	$76,900
3.2 Training on GIS Program	-	-	28,350			2,000			-	30,000	350	30,350
3.3 Prepare & Publish Final Report	10,800	1,620	5,000			500			2,160	15,000	5,080	20,080
3.4 Conferences & Seminars	5,400	810	6,000			1,000			1,080	10,000	4,290	14,290
Report Activity Subtotals	**$70,200**	**$10,530**	**$39,350**	**$0**	**$0**	**$7,500**	**$0**	**$0**	**$14,040**	**$65,000**	**$76,620**	**$141,620**

	Direct Labor	Fringe Benefits	Subcontract Services	Materials	Equipment	Travel	Misc.	Indirect Overhead	G&A Overhead	Cost Share	CALFED	Total
PROJECT TOTAL	**$129,000**	**$19,350**	**$1,106,850**	**$25,000**	**$25,000**	**$25,000**	**$9,000**	**$0**	**$25,800**	**$765,000**	**$600,000**	**$1,365,000**
										56%	44%	100%

* Direct labor rate of $90/hr for Mr. Enzweiler and $80/hr for Dr. Stoddard; markups for fringe and G&A are WaterTech's audited rates under similar contract with California Energy Commission

Personal Services	Operating Expenses	Other	Grand Total
$148,350	**$1,190,850**	**$25,800**	**$1,365,000**

2/15/01

Exhibit C

Sample Letter to be Sent to Water Districts Serving the Participating Farms

Dear (General Manager):

The CALFED Bay-Delta Program has commissioned JMLord, Inc. and WaterTech Partners to conduct an on-farm irrigation scheduling study as part of CALFED's Water Use Efficiency Program. The goal of our project is to determine and document the direct and indirect on-farm cost savings and external benefits that growers can achieve by using irrigation scheduling to reduce applied water use and to maximize water use efficiency on various crops in six hydrologic sub-regions of the San Joaquin Valley.

We have identified 19 farms comprising approximately 28,000 acres in the valley that currently use, or have expressed an interest in using, scientific weather-based irrigation scheduling as part of their farming operation. Each of these growers is being asked to participate in the project, which will be conducted over a three-year data collection and monitoring period (the 2002, 2003 and 2004 irrigation seasons). For each participant, JMLord will develop an annual water balance for the scheduled acreage; calculate water use efficiency for each crop; monitor the use and costs of pesticides and fertilizers; document product quality improvements; and monitor runoff and groundwater salinity levels where appropriate. The site-specific information will be recorded in a Geographic Information System (GIS) data base for each field in each participating farm for comparison against crop yield, water use, and pesticide and fertilizer use on similar cropland that is irrigated, but not with the benefit of scientific irrigation scheduling methods.

We are asking that *(name of district,)* along with several other local districts, agree to be cooperators in the study by furnishing data that will assist us in the measurement of the benefits and supporting the "outreach" phase of the project. A key element of the project will be to publicize the results that are achieved and to transfer the expertise that is developed regarding GIS databases to other agricultural water users and irrigation districts. JMLord will provide hands-on training to irrigation district staff members and others who wish to learn how to set up and use a GIS database to track water use and other variables as part of a comprehensive irrigation management program.

We will be contacting you during the next few weeks to discuss your participation in this very worthwhile project that offers an opportunity to promote practical water use efficiency among agricultural water users by expanding the use of weather-data based irrigation scheduling in the San Joaquin Valley. In the meantime, if you have questions please contact JMLord, Inc. at 559-268-9755 regarding the project: **"Quantification of Benefits Attributable to Irrigation Scheduling as an On-Farm Water Management Tool."**

Sincerely,

JMLord, Inc.

Exhibit C (continued)

Sample Letter to be Sent to Farmers as Expected Participants

Dear Grower:

The CALFED Bay-Delta Program has commissioned JMLord, Inc. and WaterTech Partners to conduct an on-farm irrigation scheduling study as part of CALFED's Water Use Efficiency Program. The goal of our project is to determine and document the direct and indirect on-farm cost savings and external benefits that growers can achieve by using irrigation scheduling to reduce applied water use and to maximize water use efficiency on various crops in six hydrologic sub-regions of the San Joaquin Valley.

We have identified 19 growers, including you, which farm approximately 28,000 acres in the valley who currently use, or who have expressed an interest in using, professional irrigation scheduling as part of their farming operations. Each is being asked to participate in the project, which will be conducted over a three-year data collection and monitoring period (the 2002, 2003 and 2004 irrigation seasons). JMLord will develop an annual water balance for the scheduled field; calculate water use efficiency for each crop; monitor the use and costs of pesticides and fertilizers; document product quality improvements; and monitor runoff and groundwater salinity levels where appropriate. The site-specific information will be recorded in a Geographic Information System (GIS) data base for each field in each participating farm for comparison against crop yield, water use, and pesticide and fertilizer use on similar cropland that is irrigated, but not with the benefit of scientific irrigation scheduling methods. Local irrigation districts in the study area are being asked to cooperate in the study by furnishing data that will assist us in the measurement of the benefits.

The identity of the individual farmers participating in the project and data about their farming operations will be kept confidential. No names of individuals or farms will be disclosed or used in publicly released documents, unless a participant's approval is obtained. All contact with the participating farmers will be through JMLord, Inc. We will share all data with our participating clients and provide a personal summary report of each season**. There will be no additional costs to you for participating in this project.** You will only pay the same amount as you would otherwise pay for irrigation scheduling services. The additional costs for development of the GIS date base, collection of data for the comparative analyses, and other project activities will be covered by a CALFED grant.

We will be contacting you during the next few weeks to discuss your participation in this very worthwhile project that offers an opportunity to promote practical water use efficiency among agricultural water users by expanding the use of weather-data based irrigation scheduling in the San Joaquin Valley. In the meantime, if you have questions please contact JMLord, Inc. at 559-268-9755 regarding the project: **"Quantification of Benefits Attributable to Irrigation Scheduling as an On-Farm Water Management Tool."**

Sincerely,

JMLord, Inc.

EXHIBIT D

RÉSUMÉS OF PROJECT TEAM MEMBERS

WaterTech Partners

Ronald J. Enzweiler, P.E.
(Project Manager)

Albert Stoddard, Ph.D.

JMLord, Inc.

Joseph M. Lord, Jr., P.E.
(Project Technical Director)

Mike Ransom

Tomas A. Vera

James L. (Larry) Howard, P.E.

Sheldon T. Childs

Carter Pierce

Robert J. Gulack

GIS Data Base Consultant

Wesley Wallender, Ph.D.

RONALD J. ENZWEILER, P.E.

5 Corte Fresca • Moraga, California USA 94556
Voice: 925-283-4918 • Fax: 925-283-7458 • e-mail: ron@h2o-tech.com

CAREER SUMMARY

Mr. Enzweiler is a versatile, task-oriented, self-motivated executive and creative problem-solver with over 20 years experience developing, managing and marketing new process technologies and innovative services for agricultural, industrial and municipal applications in the water, environmental, energy and chemical industries.

- As **consultant** and **entrepreneur,** has identified new business opportunities, developed corporate strategies, prepared business plans, licensed patent rights, raised equity financings, and built and led organizations that have developed and tested several new water and wastewater treatment technologies and/or service concepts

- As **corporate executive** and **Harvard MBA**, held profit & loss responsibility for $50 million/yr industrial gas supply business as part of $5-billion multinational corporation; doubled sales and profits of this business over 3 year period; as part of job, managed design and construction of new facilities costing over $100 million

- As **project manager** and **P.E.** with **M.S. in Civil Engineering from MIT**, possesses broad knowledge of water and wastewater treatment technologies, facilities, operations, and regulatory issues; has secured and managed over $10 million in R&D contracts funded by various governmental entities

REPRESENTATIVE R&D PROJECTS & RELATED EXPERIENCE

- Investigated feasibility of launching a private agricultural water conservation and water transfer/marketing business in California for multinational French company (1999-00)

- Developing new “closed-loop” chiller-bath water recycling system for poultry processing using ozone and membrane technology under $600,000 Public Interest Energy Research contract with California Energy Commission and EPRI (1998- present)

- Formed multinational team that developed design, prepared preliminary cost estimates, and pursued financing development bank for $250 mm municipal water purification system for Palestinian National Authority for Gaza involving brackish groundwater and seawater desalination using reverse osmosis (1994-95)

- Participated in development of new industrial pretreatment standards for Palo Alto, Sunnyvale and San Jose by establishing "best demonstrated available technology;" developed and proposed plan for allocating additional pretreatment cost for meeting new NPDES permit among all users of the municipal systems (1992-93)

- Proposed, negotiated and performed $1,500,000 cost-shared commercial demonstration contract with the Sandia National Laboratories for advanced metals-removal wastewater treatment process (1991-92)

- Developed (in conjunction with Citizens Environmental) a system-wide pollution credit trading plan for industrial dischargers in the Massachusetts Water Resource Authority; plan involved the use of advanced treatment technologies and centralized on-line effluent monitoring system (1992)

- Designed "zero discharge" closed-loop water system for a chemical plant in Boulder, Colorado, which enabled client to avoid surcharge fees, conserve city water use, and gain public support (1993)

- Managed pilot-scale tests to determine costs and treatment effectiveness of technologies for removing disinfection by-product precursors from municipal drinking water supplies; tests done in collaboration with by EPA laboratories and universities under AWWA and WEF funding (1990-91)

- Evaluated market potential and regulatory considerations for using new solar-driven process for detoxifying municipal sewage effluent for agricultural and other non-potable uses; developed conceptual plant design in conjunction with Dept. of Energy’s National Renewable Energy Laboratory (1993-94)

- Led multi-disciplined project team that developed, designed and field tested new membrane wastewater-treatment process for use on off-shore platforms to meet new discharge regulations (1989-90)

- Managed business unit that designed, built, operated and financed cryogenic and pressure swing adsorption oxygen plants for supplying municipal and industrial wastewater treatment works (1984-88)

EMPLOYMENT HISTORY

CURRENT **WATERTECH PARTNERS** **Moraga, California**

1994 Principal & Owner Environmental engineering, consulting, and project management firm that specializes in developing and implementing innovative solutions for difficult or unique environmental problems. Also involved in commercializing new water purification, hazardous water treatment, and pollution prevention technologies. Assignment performed for industrial, venture capital and government clients. Specials interest in CALFED program, water issues and biosolids.

CLEARFLOW, INC. **Boulder, Colorado**

1991-94 President & CEO Founded this company in 1991 as merger of two R&D firms. Pursued the commercialization of solar water-detoxification technology developed by DOE national laboratories and universities. Raised over $3 million in funding from government and venture capital sources. Recruited and directed eight-person professional staff and completed field testing of prototype for wastewater treatment. Developed potential $20 million niche market.

1988-91 **AQUAAIR ENVIRONMENTAL, INC.** **Bend, Oregon**

President & CEO Founder this startup whose focus was commercializing advanced membrane-based systems for water purification, wastewater cleanup, and air-pollution control using proprietary technology licensed from Bend Research, Inc. Raised over $2 million early-stage financing from venture capital and corporate investors. Recruited management team, set up product development and manufacturing operations, and developed and implemented market-entry strategy

1982 -1988 **LIQUID AIR CORPORATION** **Walnut Creek, CA / Paris, France**

Vice President & General Manager of the build-own-operate division of Liquid Air Corporation, the $500 million U.S. subsidiary of the $5-billion worldwide L'Air Liquide Group of France. Joined Liquid Air in 1982 as a Sales Manager. Promoted to Vice President in 1984 and given profit/loss and general management responsibility for existing $25 million on-site oxygen, nitrogen, and hydrogen supply business. Secured new contracts that doubled sales and profits. Major projects with Texas Instruments, U.S. Steel, Borden Chemical and BASF.

EDUCATION

INSEAD **Fountainbleau, France**

Advanced Management Programme – April 1985. International program for senior executives, curriculum focused on corporate planning and competitive strategies/advantages within industry.

Harvard Graduate School of Business **Boston, Massachusetts**

Master in Business Administration – June 1978. Concentration was Production & Operations Management. J. S. Love Fellowship. First-Year Honors. Captain of HBS Rugby Club.

Massachusetts Institute of Technology **Cambridge, Massachusetts**

Master of Science from School of Civil and Environmental Engineering – February 1979. Followed project management and process technology curriculum.

Georgia Institute of Technology **Atlanta, Georgia**

Bachelor of Industrial & Systems Engineering with Honor – August 1972. Tau Beta Pi. Football scholarship, lettered three years and played in two bowl games. Air Force ROTC Cadet.

MILITARY SERVICE

U.S. AIR FORCE

1974 -75 1st Lieutenant / Project Management Officer **Bitburg Air Base, German**

1972 -74 2nd Lieutenant / Base Civil Engineering Officer **Ellsworth AFB, South Dakota**

CIVIC & PROFESSIONAL AFFILIATIONS

Councilmember, Moraga Town Council, 1996-00
Representative, League of California Cities, 1996-89
Commissioner, Contra Costa Transportation Authority, 1998-00
Member, California Water Environment Association , 1992- present
Registered Professional Engineer, Colorado, 1979 - present

Albert A. Stoddard III

P.O. Box 1993 • Hanford, CA 93232-1993
Voice & Fax: (559) 583-6655 • e-mail stoddard@cnetech.com
Web site: http://members.cnetech.com/stoddard

Note: Dr. Stoddard will be employed on a part-time basis by WaterTech Partners during the project and will be primarily responsible for evaluating the off-site impacts and benefits that reductions in applied water use will have on the CALFED QOs and TBs which this project will address. His expertise in agrichemicals makes him uniquely qualified for this assignment.

Education:

B.S. University of Florida Major: Fruit Crops, Agronomy (8/85,8/86)
M.S. University of Florida Major: Agronomy; Minor: Botany (6/89)
Ph.D. University of Georgia Major: Crop and Soil Sciences (6/98)

Experience: *(Reverse Chronology)*

1998- ***Agricultural Consultant*** – **Rush, Marcroft and Associates**

Duties include: private consulting to clients (ranchers, agrichemical producers/retailers, attorneys, and insurance companies) where crop failure or significant crop damage has occurred, and/or where litigation is involved; conduction of pertinent field research and literature review; coordination of sampling and interpretation of laboratory analysis; expert witness testimony; complete third-party documentation, estimation, causal determination, and reporting of crop damage.

1994-98 ***Graduate Research Assistant*** - **Crop and Soil Sciences, University of Georgia**

Duties include or have included: a program of study (detailed below); the conduction of dissertation and other research (detailed below); assistance in the conduction and analysis of grant research funded by the Electrical Power Research Institute and the pulp and paper industry; lab instruction and teaching assistance in Soils and Hydrology (CSS/FRS 306L); coordination of Soils Discussion Group Seminar Series within the department; and departmental student representative for the College of Agriculture and Environmental Sciences Strategic Planning Conference.

Program of Study: Emphasis in soil and aquatic physical chemistry; advanced coursework in chemical speciation modeling (MINTEQ), unsaturated flow modeling (VS2DT), and mineralogy; basic coursework in hydrology, soil physics, soil conservation, soil morphology, and soil microbiology; analytical experience in various wet chemistry procedures, AAS, XRD, thermal analysis, colorimetry, TOC analysis, IC, ICP-MS.

Dissertation Subject(s): Manuscripts in preparation/submission (Journal):

1. Wetting rate, aggregate size, and synthetic polymer effects on infiltration and erosion (Soil Sci Soc. Am. J.)
2. Polyacrylamide effect on erosion, fertilizer runoff, and plant establishment on disturbed soil (Soil Tech.)
3. Effects of coal combustion by-products on runoff and interill erosion (Soil Sci.)

1993-94 ***Citrus Researcher*** - **Barron Collier Co.**

Duties included the implementation and management of field research to augment a continuous production improvement process on an economic and yield basis; proactive communication, cooperative experimentation, and maintenance of research with university research and extension arms; implementation of statistical techniques to accurately estimate annual yields for in-house accounting purposes and for contract fruit buyer processing allotments and hedging operations; technical support on an as-needed basis to management.

1989-92 ***Product Development Specialist*** **- Unocal Corporation**

Duties included the development of technical information on proprietary agrichemical product uses in new market areas; evaluation of product potential, recommendation and prioritization of crop uses to be developed; establishment of professional relations with customers (dealers and end-users); coordination of product development with universities (grant-in-aid) and regulators (registrations); and new introductory management of products in cooperation with marketing groups. Products developed for the Florida and Georgia agronomic and horticultural markets included urea-sulfuric acid for herbicide, desiccation, and water treatment uses, low-biuret liquid foliar urea use in citrus, novel herbicides, and cotton defoliants and harvest aids.

1986-89 ***Graduate Research Assistant*** **- Agronomy, University of Florida**

Duties included the implementation of greenhouse and field research to evaluate the effects of photoperiod and plant growth regulators on weed-crop interaction (thesis research). Implementation, maintenance, sample shipment, and efficacy evaluation for dissipation and residue sampling experiments for USEPA registration of herbicides such as imazethapyr and lactofen. Other duties included lab instruction for PLS 4601 (Weed Science), and assistance in the conduction of research for grants, scientific journals, and popular press. Elected by peers as graduate student representative to faculty, 1987-88.

Refereed Publications:

Stoddard, A.A. 1998. The use of polymers and coal combustion by-products for amelioration of crusting in disturbed soils. Ph.D. Dissertation. University of Georgia, Athens, GA

Stoddard, A.A. 1989. Environmental factors affecting sicklepod (Cassia obtusifolia) interference in soybean. M.S. Thesis. Univ. of Florida, Gainesville, FL

Note: three (3) manuscripts under submission/review

Popular Publications:

Stoddard, A.A. 1989. The phytogeography and paleofloristics of Pistia stratiodes L. *Aquatics Magazine.* Florida Aquatic Plant Management Society. 11(3):21-24

Stoddard, A.A. 1987. Wild Rice. *Aquatics Magazine.* Florida Aquatic Plant Management Society. 9(4):4-8

Abstracts:

Stoddard, A.A. and W.P. Miller. 1997. Initial size, prewetting and PAM effects on aggregate stability and crusting. Agronomy Abstracts. Vol. 89

Stoddard, A.A., D.W. Rush, and M.L. Atwater. 1991. Enquiktm weed control programs in Florida horticultural crops. Proc. South Weed Sci. Soc. Vol. 44

Stoddard, A.A., M.L. Atwater, and D.W. Rush. 1990. Post-emergence weed control in citrus using Enquiktm. Proc. South. Weed Sci. Soc. Vol 43

Stoddard, A.A. and D.G. Shilling. 1988. Factors affecting sicklepod (Cassia obtusifolia) interference in soybean. Proc. South Weed Sci. Soc. Vol. 44

Professional/Society Memberships:

Soil Science Society of America. 1997 - Present
California Chapter, American Society of Agronomy. 1999
California Weed Science Society. 1999
National Association of Independent Crop Consultants. 1998

Professional Licenses/Certifications:

California Agricultural Pest Control Advisor (PCA) #AA3034, Categories A,B,E
Home County: Kings

California Agricultural Qualified Applicator License (QAL) #37923, Categories C,D,F,J
Home County: Kings

Joseph M. Lord Jr., P.E.

President and
Chief Operating Officer
JMLord, Inc.

EDUCATION

B.S., Civil Engineering, State University of Iowa, 1962

PROFESSIONAL REGISTRATION AND AFFILIATION

Agricultural Engineer: California
Civil Engineer: California, Arizona, Nevada, Colorado, Oregon and Texas
American Society of Agricultural Engineers
American Society of Civil Engineers
U.S. Committee on Irrigation, Drainage, and Flood Control
California Irrigation Institute

HONORS

Recipient of "Irrigation Person of the Year" Award Presented by the California Irrigation Institute, February 1998
Past President of the California Irrigation Institute
Past Advisor to the Office of Water Conservation, Department of Water Resources,
State of California

EXPERIENCE

Mr. Lord has been operating his own consulting firm since 1979. This firm provides a broad spectrum of professional services to agricultural water users and operates a complete agricultural laboratory. JMLord, Inc. has clients throughout the United States, as well as internationally. A list of major projects that Mr. Lord personally participated in are as follows:

- Directed an investigation and authored a comprehensive report on the agricultural assets of a 9,100 acre property in Kern County, California.
- Selected as a member of a five-person panel of experts to review existing information and develop a comprehensive report on Colorado River water use by Coachella Valley Water District and Imperial Irrigation District.
- Designed and directed a "Water Needs Assessment" for several water districts in support of their Contract Renewal Negotiations and Conservation Plans.
- Principal in charge of performing a detail survey of soil salinity conditions of a 90,000 acre water district, and preparation of a report for management of irrigations to address the agricultural salinity hazards.
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- Principal in charge of feasibility studies for developing a conjunctive use and water supply improvement program in Mokelumne River Basin.
- Project manager for a two-year study and report for inventory and evaluation of 21,000 acre drainage district on west side of San Joaquin Valley. This study produced a master plan that was accepted by district directors.
- Directed a three-year demonstration project that developed controlled drainage concepts in groundwater management for production agriculture in the San Joaquin Valley.

- Directed a statewide study and report of Water Districts in California for Department of Water Resources to evaluate factors affecting their water delivery flexibility.

- Directed a two year investigation for the ERDA to identify and quantify energy use and potential savings with on-farm water management in irrigated agriculture.

- Conducted a soil survey of 25,000 acres of reservation lands for the Fort Yuma Indians.

WORK HISTORY

1973 - 1979 Harza Agricultural Services, Fresno, California
President and Manager. Directed water and fertility management programs, providing consulting services in the San Joaquin Valley of California. Engaged in contracts for irrigation and drainage system design, and topographic and soil mapping.

1971 - 1973 U.S. Bureau of Reclamation, Denver, Colorado
Coordinator of the Irrigation Management Services program. Responsible for developing the applied research program for improving irrigation efficiencies with on-farm water management.

1967 - 1971 U.S. Bureau of Reclamation, Bangkok, Thailand
Drainage Engineer in charge of drainage investigations for the PaMong Project and other projects in Laos and Thailand.

1964 - 1967 U.S. Bureau of Reclamation, Denver, Colorado
Hydraulic Engineer in the Water Utilization Section.

Prior to 1964 Boeing Company, Seattle, Washington
Flight Test Engineer on the Minuteman Missile and Scientific Programmer.

Mike Ransom

Database Engineer

Systems Analyst

EDUCATION

M.S.E.E., Northeastern University, Boston, Massachusetts
B.S.E.E., University of Illinois, Urbana, Illinois

CAREER SUMMARY

Mr. Ransom provides a broad range of expertise and experience. As a Database Engineer, Mr. Ransom has completed the **Oracle Database Masters Courses**. He is experience with Oracle, Microsoft SQL, Access and more. As a programmer, Mr. Ransom has working knowledge of Visual Basic, C++, and more. He has experience with the following networks and Operating Systems: Microsoft Windows NT, Windows 2000, Windows 98/95, and Novell. Mr. Ransom has directed efforts that include WAN/LAN technology, Infrastructure, EDI, WEB Services, and Internet Services to include selection of technologies, contracting, installation, operation and maintenance. Mr. Ransom has significant experience with the AS-400 and all forms of connectivity.

REPRESENTATIVE PROJECTS & EXPERIENCE

- Mr. Ransom has developed the proprietary ***WETbase*** database for JMLord. This water district management tool provides entity tables, efficiencies and other important data useful for managing water district operations.
- Mr. Ransom has directed and managed the MIS Division for **Premier Valley Foods**. This effort includes the Management of the AS-400 and over 100 workstations, the BPCS Enterprise system, the EDI system, the E-Mail system, the WAN/LAN systems, 5 Novell Servers, the internet system, and the WEB system.
- Mr. Ransom has directed and managed the MIS efforts for the Western Division of **Del Monte Foods**. This effort included new systems developments for a SQL Server warehouse database, a new time clock systems, design of warehouse network infrastructure and daily operation and maintenance systems for 13 sites.
- Mr. Ransom supported **Nestle** as a Computer Systems Analyst. He programmed databases and maintained over 100 PC's in two plants. Mr. Ransom developed a model for mass flow of tomatoes, designed the database and implemented the design. Additionally, Mr. Ransom developed a real time Line Status Database that allowed plant running statistics and operational status at all times. Mr. Ransom also supported the implementation and maintenance of as Oracle Database for Maintenance.
- Mr. Ransom's experience includes working for the **San Joaquin Valley Unified Air Pollution Control District** where he installed 2 networks and maintained 50 PC's. He also evaluated permits for grain operations, oil drilling operations, food manufacturing operations, and paint stray operations.
- Mr. Ransom also worked at **Qualimetrics** as a maintenance director for weather equipment manufacturing. While there, he completed installation design of automated weather stations and managed the installation of over 200 FAA weather sited. He was qualified by the FAA in depot level repair of weather instruments.
- Mr. Ransom is a Regular United States Officer (RET).

Tomas A. Vera

Chemist and
Laboratory Manager

EDUCATION

B.S., Physics, Chemistry Minor, Sonoma State University, California, 1984

HONORS

Navy Achievement Medal awarded for Superior Performance as a Cryptology Systems Officer.

Certificate of Honor from BSK Analytical Laboratories for Performing the Tasks and Responsibilities of Two Full-Time Positions.

EXPERIENCE

Mr. Vera has worked in the areas of environmental and agricultural chemistry since 1990. He performs a wide variety of tasks ranging from sample preparation, to laboratory administration. In addition, he has practical experience with and knowledge of computer software, hardware, and networks, as well as programming expertise utilizing a variety of platforms and languages. An overview of his experience, capabilities, and achievements is summarized below.

- Specified, obtained, and oversaw the installation and verification of an Inductively Coupled Plasma Spectrometer used for metals analysis in plant, soil, and water sampling.
- Developed new and updated older analytical methods used in the analysis of plant, soil, water, and wastewater, making the analytical process more efficient and accurate.
- Created a computer database application for use by dairies in the monitoring of dairy waste for compliance with federal, state and local agency requirements.
- Installed a ten station Novell network, including development of specifications for the serve and work stations, and assisted with the cabling installation.
- Wrote Windows-based computer software used to compare different algorithms used in the calculation of plant evapotranspiration rates.
- Developed and manages a World Wide Web internet site, including the authoring software used in development of the site.
- Developed a template for the design, staffing, and equipping of a standard agricultural laboratory with emphasis on sample handling efficiency, worker safety, automated reporting of results, and hazardous waste disposal.
- Developed a complete Health and Safety Program that met and exceeded requirements of state and federal OSHA's.
- Member of the ActLABS Hazardous Waste Management Subcommittee responsible for the enactment of California's tiered permitting hazardous waste laws.
- Co-developed a Certified Sampler Program used to train water system operators in sample collection and reporting under the federal Total Coliform Rule.
- Created a database application to track and automate supply ordering and billing.
- Assisted in the specifications and selection of a Laboratory Information Management System.

- Instrumental in the installation and verification of a Flow-Injection gold-amalgamation mercury analysis system, and refined analytical methods used to prepare samples for analysis.

- Wrote QC software that allowed laboratory staff to use a single, coordinated data reduction and reporting system.

- Coordinated the distribution and implementation of the Secure Telephone Unit (STU-III) to elements of the 1st Marine Division.

- Developed and lead a training program on the KL-43 Cryptology Device for elements of the 1st Marine Division.

- Worked to standardize the use of cryptology software and equipment for US Marine units in the Pacific theater, including 1st Marine Division, 1st Marine Expeditionary Force, and 5th Marine Amphibious Brigade.

- Developed a program for USS Marvin Shields (FF-1066) personnel to coordinate inter-division repair and maintenance tasks.

- Responsible for the prosecution and administrative separation of several sailors found to be in violation of the Uniform Code of Military Justice.

- Qualified as a Surface Warfare Officer, Officer of the Deck (Underway), Command Duty Office.

WORK HISTORY

1994 - Present **JMLord, Inc.** **Fresno, California**
Laboratory Manager. Responsible for supervising chemists/technicians in the daily operations of an agricultural laboratory. Performs chemical analyses. Administration and maintenance of the computer network.

1991 - 1993 **BSK Analystical Laboratories** **Fresno, California**
Log-In Supervisor/Health and Safety Officer. Supervised sample custodians in the operation of the Sample Log-In Department. Developed and maintained the Health and Safety Program

1984 - 1989 **US Navy**
Surface Warfare Officer. Assigned to 1st Marine Division and USS Marvin Shields.

James L. (Larry) Howard

Civil Engineer

EDUCATION

A. A. – Reedley College - Reedley, California: 1971
B.S. (Civil Engineering) – California State University Fresno, Fresno, California: 1974

PROFESSIONAL REGISTRATION

Registered Civil Engineer (California 1977) – RCE 27036

CAREER SUMMARY

Mr. Howard worked in a broad range of civil engineering capacities since 1970, ranging from land development and commercial building design to water resources planning and development. His education, design and field experience, extensive work with various federal, state and local regulatory agencies, as well as personal on-farm activities uniquely qualifies him to provide superior professional services to JMLord clients.

WORK EXPERIENCE

1999 - ***Project Manager*** **-- JMLord, Inc.** **Fresno, California**

Manages JMLord's relationships with agricultural water district and assist districts in the preparation of water management plans, conversation program, contract negotiations with USBR, and internal operations and management. Also assists growers in evaluating irrigation systems and on-farm water management.

1993-1999 ***Environmental Compliance & Safety Manager*** **-- Basic Vegetable Products**

- Corporate responsibility for compliance with environmental and employee health and safety regulations related to the planting, harvesting and processing of vegetable crops in California, Oregon and Washington.
- Corporate loss control responsibilities related to capital improvements, air and water quality, workers' compensation and liability.
- Served as one of five team leaders for the Core Business Initiative re-engineering project.
- Certified as a Zenger-Miller trainer, authorized to deliver training in all Z-M subject areas.
- Designed and conducted numerous training programs in communications, environmental compliance, safety, and labor relations.

1990-1993 ***Safety Director*** **-- Sun-Maid Growers of California**

- Responsible for environmental and safety compliance at Sun Maid's facilities in Kingsburg and Orange Cove California.
- Developed and implemented an injury and illness prevention program mandated by California Senate Bill 198.
- Developed training program for administrative and plant employees that became model for the industry

1989-1990 ***Principal Engineer*** **- Ag Water Communications**

- Strategic communications for public and private agricultural, water and land-development clients
- Liaison with federal, state and local regulatory agencies.
- Engineering cost estimates for agricultural and water resources projects.
- Negotiations for water exchanges and transfers.
- Environmental impact analyses.
- Federal and state legislation tracking.

1975-89 ***Assistant Manager; Chief, Planning Division; Chief, Engineering Division; Assistant Engineer***
Kings River Conservation District

- Design, construction management, and maintenance of drainage, water supply, and flood control structures.
- Maintenance supervision of 165 miles of flood control levees on the lower Kings River.
- District's liaison with the State Reclamation Board.
- Prepared applications and secured all necessary federal, state, and local regulatory agency permits for the Pine Flat Power Plant, a 165 megawatt hydroelectric power plant on the Kings River at Pine Flat Dam.
- Project manager for economic feasibility and environmental studies for the Dinkey Creek Hydroelectric Power Plant on the Kings River watershed.
- Prepared applications and secured permits from the Federal Energy Regulatory Commission, U.S. Army Corps of Engineers, U.S. Forest Service, California Public Utilities Commission, State Water Resources Control Board, California Department of Fish and Game, State Lands Commission, Central Valley Regional Water Quality Control Board, and Fresno County.
- Conducted appraisals and negotiated land purchases and leases.
- Negotiated power sale contracts with Southern California Edison and Pacific Gas & Electric.
- Conducted numerous public meetings and successfully negotiated environmental mitigation agreements with public agencies and environmental organizations.
- Presented testimony before the U.S. Senate Committee on Water and Power.
- Served three years as member of the Association of California Water Agencies (ACWA) Energy Committee.

Assistant Engineer **-- G.A. Wayadande & Associates**

- Design, cost estimating, field surveys, and construction inspection of commercial and residential subdivisions.
- Structural calculations and drafting for commercial buildings (public libraries, recreation centers)

Assistant Engineer -- George Burnham & Associates –

- Planning, design and field layout of various private land development projects.
- Municipal sanitary sewer and storm drain design, layout and inspection.
- Boundary and topographic surveys, parcel maps, records of survey in Fresno, Kings and Tulare counties.

Sheldon T. Childs

Agronomist
Irrigation Systems Specialist

EDUCATION

M.S. Agriculture, with a Specialization in International Agriculture Development with distinction; California Polytechnical State University, San Luis Obispo 1989-1991

B.S. Natural Resource Management; Colorado State University, Fort Collins 1980-1984

WORK HISTORY

1995 – **Valley Agronomy Services**
Independent Consultant - Conducts irrigation scheduling, irrigation systems evaluations, pest and fertility management services for seven farms on both sides of the San Joaquin Valley. Conventional crops: cotton, tomatoes, garlic, onions, almonds, bean, and small grains. Organic production of tomatoes, carrots and onions.

1991-95 **Five Points Ranch**
Agronomist/Assistant Manager - Performed irrigation scheduling, water accounting, pest and fertility management, and worker safety training. Evaluated and modified sprinkler, furrow, micro and drip irrigation systems. Trained and supervised furrow irrigators and pesticide applicators.

1990 **Farming Systems, Kenya**
Livestock Officer - Supervised and trained field extensionists. Revamped record keeping and reporting systems. Set-up and implemented new guidelines for time management by field personnel. Planned and launched training and financing activities for a Zero Grazing Project that assisted 500 small farmers in thirteen communities.

1988 **Ministry of Agriculture, Guatemala**
Extensionist - Planned and directed the construction of six community and fifteen family coffee processing plants. Provided training, support and technical assistance to coffee cooperatives and local extensionists.

1985-87 **U.S. Peace Corps, Guatemala**
Extensionist - Set-up and conducted vegetable, fruit tree and cover crop demonstration plots. Developed, established, and coordinated five community fruit tree nurseries. Guided, secured funding, and assisted in the construction of three community potable water systems.

Carter Pierce

Agricultural Operations

EDUCATION

B.S. Agricultural Science, California Polytechnic State University
A.S. Animal Science, Reedley Junior College, Reedley, California 1978

CERTIFICATIONS AND SKILLS

1991 KARRASS Negotiating Seminar Certification
1991 Kings River Community College (Conversational Spanish)
1990 C.I.P. (Continuous Improvement Program for Management)
1990 College of Sequoias (Spanish in the Field)

HONORS AND ACHIEVEMENTS

1977 National 4-H Leadership Presidential Tray Award Recipient

CURRENT POSITION

Mr. Pierce coordinates and promotes the technical services of **JMLord, Inc**. for the support of agri-business clients throughout the San Joaquin Valley. Mr. Pierce has been a key person in developing JMLord, Inc., confined animal monitoring program, as well as JMLord's irrigation scheduling business.

PREVIOUS EXPERIENCE

- From 1991 to 1995, Mr. Pierce supervised the sweet potato and almond operations at **M & K Farms** in Selma, California. Responsibilities as ranch manager included supervision of production, harvest, chemical application, crop transportation, and in-house sales. He was also in charge of the almond huller and trucking.

- From 1990 to 1991, Mr. Pierce was Garlic Production Representative for **Basic Vegetable Products** of Hanford, California. He contracted acres to be grown and negotiated the price to be paid with grower. He supervised all phases of plant growth and coordinated harvest procedures.

- From 1984 to 1987, Mr. Pierce served as Office Manager for **Britz Fertilizer and Chemical Company** in Hanford. He supervised duties performed by sales and non-sales personnel. He maintained material invoices and company correspondence through computer input.

- From 1983 to 1984, Mr. Pierce was outside sales representative for **Moor Mans Feed Supplement** in Stockton, California. Duties were to provide direction to ranches for more efficient milk production and make related supplemental sales.

- Other experience included work involved with his father's Angus cattle ranch in Creston, Illinois, and his family's diversified farms and dairies in the Selma, California area.

Robert J. Gulack

Agronomist

Agronomy, specializing in water and fertility management. crop expertise includes citrus, avocados, stone fruits, figs, almonds, walnuts, grapes, cotton, tomatoes, garlic, onions, wheat, sugar beets, safflower, melons, broccoli, peas, beans. Work closely with growers on budget development for a variety of cultural practices including land preparation, harvest, chemical applications and materials, fertilizers, and water.

EDUCATION

Oregon State University, Corvallis, Oregon July 19976 – April 1982
Major: Soil Science – Emphasis on Soil Fertility G.P.A. – 3.89
Thesis topic: The impact of Nickel Refining By-Products on Agricultural Lands
Degree: Master of Science pending. All course work and field studies completed.
Final copy of thesis paper not submitted. Reason – full time employment.

California State University, Fresno
Fresno, California January 1974 – May 1979
Major: Geography – Environmental Science
Minor: Plant Science – Emphasis on Soils G.P.A. – 3.74
Degree: Bachelor of Arts, Magna Cum Laude, May 1979

CERTIFICATION/LICENSES/MEMBERSHIPS

American Society of Agronomy
Soil Science Society of America
California Society of Agronomy
California Agricultural Pest Control Advisors
Association of Applied Insect Ecologists
California Agricultural Pest Control Advisor #6350 – until 1/96
California Agricultural Pest Control Operator #6350 – until 1/96

EXPERIENCE

1986 – Gulack Consulting Services – Corporation President – ***Head Agronomist***

Responsibilities: company contracted to conduct irrigation scheduling, fertility management, and pest management (cotton and grapes only) on up to 25,000 acres (8-10 growers) of trees, vines, and row crops. Employs 2 to 5 people. Monitoring of soil moisture, evaluation of crop development and weather conditions, with appropriate data input into computerized irrigation scheduling program, and insect monitoring, and generation of fertility and pest management reports and recommendations. Preparation of annual report for growers. Assist growers in development of production budgets prior to cropping year.

1994 –96 Greenleaf Farms, Inc., Porterville, California. Position: *Ranch Agronomist.*

Responsibilities: Implementation of computerized irrigation scheduling and fertility management on 4,000 acres of citrus, stone fruits, almonds, figs, kiwis and grapes. Development of annual budget for all ranch operations, and monthly monitoring of budget and expenditures. Ranch had a history of poor yields and irrigation practices. Evaluation of existing irrigation practices and irrigation systems was an integral part of establishing a sound water management program. Actually began evaluation and implementation of water management program in fall 1993 as a consultant for JMLord, Inc.

1992-94 JMLord, Inc. Position: *Agronomist*.

Responsibilities: As a private consultant, conduct irrigation scheduling and fertility management on 10 to 15,000 acres of trees, vines and row crops in the San Joaquin Valley. Working with a variety of irrigation systems, crops and soil conditions, computer generated irrigation schedules were delivered to growers on a weekly basis, incorporating farm cultural practices with timely application of water. Addition responsibilities included working for **IMS, Inc**., a sister company of JMLord, Inc. Responsibilities included on-site training of farm personnel in the use of irrigation scheduling software. This involved extensive travel throughout the west coast, and training farm personnel (usually 1-6 employees) over 3-5 days, with monthly follow-up visits.

WESLEY W. WALLENDER, Professor

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Department of Land, Air and Water Resources (Hydrology Program)
Department of Biological and Agricultural Engineering
221 Veihmeyer Hall
University of California Davis, CA 95616

Professor of Hydrologic Science and Biological & Agricultural Engineering
Ph.D. (Utah State University)
Teaching: Introduction to Geographic Information Systems (ABT 180), Geographic Information Systems Modeling (ABT 181), Hydraulics of Surface Irrigation (EBS 242), Irrigation and Drainage Systems (HYD 115/EBS 145)
Research Interests: Integrated surface-subsurface ecohydrology modeling of precipitation- and irrigation-driven watersheds using Geographic Information systems (GIS) and continuum mechanics.

CURRENT RESEARCH RELEVANT TO PROJECT

The focus is on modeling and measurement of precipitation- and irrigation-driven watersheds from meter to kilometer scales. Interests extend to water and energy conservation and to protection of the environment.

Geographic Information Systems (GIS) are being used to transfer, analyze, and display data. Complementary regional-scale hydrology models are being developed to study the time and space scale effects on predicted water flow and solute transport. Areas as diverse as a tundra region in Alaska and an irrigation district in California are under investigation. Bridging the gap in data computer structures used in GIS and the hydrology models is a related focus for the research.

The models simulate water transport from the ocean to the terminus of the watershed. Only the final leg to the ocean is missing to complete the cycle. The general purpose of this research is to link atmosphere and hydrology models, enriched by satellite data, to understand terrestrial and aquatic process from pattern at measurement scales from 20 to 1000m, and beyond to 10s of kilometers. The model will be exercised by predicting atmospheric, hydrologic and ecologic consequences of changes in land use and climate.

Changes in land use and climatic have diverse effects on terrestrial and aquatic ecosystems including but not limited to changing species distributions and changing rates of water storage and movement. Landscape structure (the spatial arrangement and number of ecosystem components) and water in the atmosphere, on the surface (sheet and stream flow), in the soil, in the ground water change in response to changes in land use as well as climate. It is vital to simulate and therefore predict the consequences of change but the simulator should be faithful to the processes and the patterns that result. Ecologists have long implied process from pattern and hydrologists are beginning to recognize this approach as they struggle to scale up from point measurements to stream flows (associated fish populations) which represent much larger areas. Satellite data offer a new opportunity to develop and test these distributed models which rely on small scale physics. The results can then be aggregated up to scales more familiar to ecologists and atmospheric scientists to combine the wealth of information from several disciplines.

Understanding the dynamic interaction between irrigation and drainage management technologies and the quantity and quality of downstream regional groundwater is one key to developing best management practices. Toward this end, data along a transect from the coast range foothills to the trough of the valley floor are being studied to determine the effect of changing water management practices.

It is generally accepted that current and future irrigation management should focus on practices that control percolation losses and salinity. Currently irrigation practices are based on average soil characteristics for a field. By including information on spatial and temporal variability of soil infiltration characteristics, management practices could be further refined. A mathematical model is being developed that will treat soil properties as stochastic, include a surface and subsurface water flow model, and incorporate crop response to soil and water quality and quantity. Field studies and modeling efforts are targeted to reduce applied water and drainage within environmental and economic constraints.